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Carbon Dates of Copper Hoard Weapons found from Nigohi Area, District Shahjahanpur U.P. India

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Introduction: *Uttar Pradesh* from *Yamuna* to *Bahraich, Ayodhya, Sultanpur* axis, north *Rajasthan*, *Haryana* and eastern *Punjab* region in north of the Indian subcontinent is primarily responsible for most of the copper hoards that have been found. These hoards, which can range in **Size** and numbers, are mostly speculated to date from the second millennium BCE. However, in absence of exact dates, there exists a debate about its antiquity. Generally, these copper hoards are often connected to the Ochre Colored Pottery (OCP). Since hoards were typically found in isolated locations or scanty cultural deposits, many of these have been found without an archaeological context. Recent findings of chariot from *Sinauli*, U.P. along with copper hoard weapons points the association of these weapons with OCP (~2000 BC)[1].

This attested that OCP people were using copper hoards (axe, harpoons, antennae swords etc.) for battle. Even some of the rock paintings of *Chitrakoot* & *Prayagraj* U.P. and eastern *Vindhyan* area south of river *Yamuna* & *Ganga* reveals invasion by copper hoard people probably because of advantage of advanced weaponry and superior military technology.

Copper hoard weapons & implements associated with OCP are harpoons, antennae swords, long & short swords, anthropomorphic figures, shouldered axes, flat celts, chisels, bar celts, currier's knives, awls, hand guards, copper ingots, bangles. Such weapons are found in Punjab, Haryana, north Rajasthan and western, central & part of eastern U.P. In addition to this, copper pieces were used to decorate chariot wheels, coffins and shields.

The present copper hoard from the Nigohi area (latitude 28^{0}06′11.36″ N and longitude 79^{0}51′53.88″ E), of district Shahjahanpur, U.P., numbering more than 200, was unintentionally discovered during farming operations. It was first retrieved by some residents of the Nigohi area. Later on, it was procured by Amit Rai Jain. Some of these weapons were embedded in clay lumps. These embedded items included a great number of anthropomorphic figures, swords, harpoons, chisels, bar celts, hand guards, axes etc. The soil in between the copper hoard weapons & tools is used for dating.

Fig. No. 01: Location of village Nigohi district Shahjahanpur in the map of India

Fig. No. 02: Location of village Nigohi district Shahjahanpur in the map of U.P.

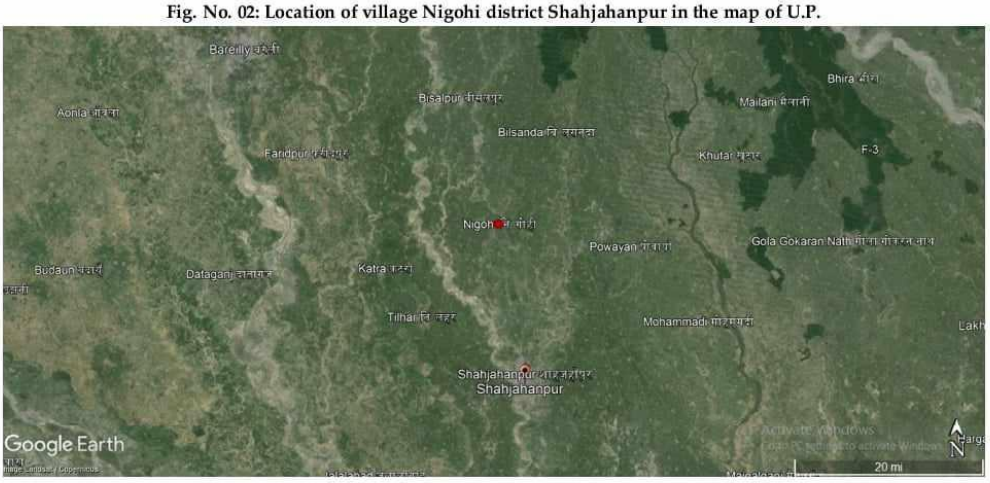

Fig. No. 03: Location of village Nigohi in district Shahjahanpur

The present investigation was initiated with the sole motive of providing proper chronological age based on radiocarbon dates, and to end the debate related to the age of the OCP culture & copper hoards found at various locations. To ascertain its provenance, and other archeological parameters, a thorough research investigation is being conducted. In this study, we report for the first time radiocarbon dates based on Accelerator Mass Spectrometry (AMS), a state of the art technique for age determination Radiocarbon dating using Accelerator Mass Spectrometer AMS)

Material and Methods: The copper hoard samples were obtained from the Nigohi, District Shahjahanpur, UP, India, along with the contemporary soil samples. Following are the weapons in different sample soil chunks sent to BSIP, Lucknow for scientific examination.

Fig. No. 04: Shouldered Axe

Accessesion No.	-	1NGH_AXE-1
Size	-	14x12x0.5 cm
Weight	-	653 gram
Description	-	It is a shouldered axe.

Fig. No. 05: Shouldered Axe

Accessesion No.	-	1NGH_AXE-1
Size	-	14x11.5x0.5 cm
Weight	-	668 gram
Description	-	It is a shouldered axe.

Fig. No. 06: Axe

Accessesion No.	-	2NGH_AXE-2
Size	-	15x10x0.5 cm
Weight	-	483 gram
Description	-	It is an axe.

Fig. No. 07: Shouldered Axe

Accessesion No.	-	2NGH_AXE-2
Size	-	16x14x0.5 cm
Weight	-	961 gram
Description	-	It is a shouldered axe.

Fig. No. 08: Shouldered Axe

Accessesion No.	-	2NGH_AXE-2
Size	-	15.5x13x0.5 cm
Weight	-	873 gram
Description	-	It is a shouldered axe.

Fig. No. 09: Shouldered Axe

Accessesion No.	-	3NGH_AXE-3
Size	-	20x17x1 cm
Weight	-	2.875 kg
Description	-	It is a shouldered axe.

Fig. No. 10: Shouldered Axe

Accessesion No.	-	3NGH_AXE-3
Size	-	20x17x1 cm
Weight	-	1.743 kg
Description	-	It is a shouldered axe.

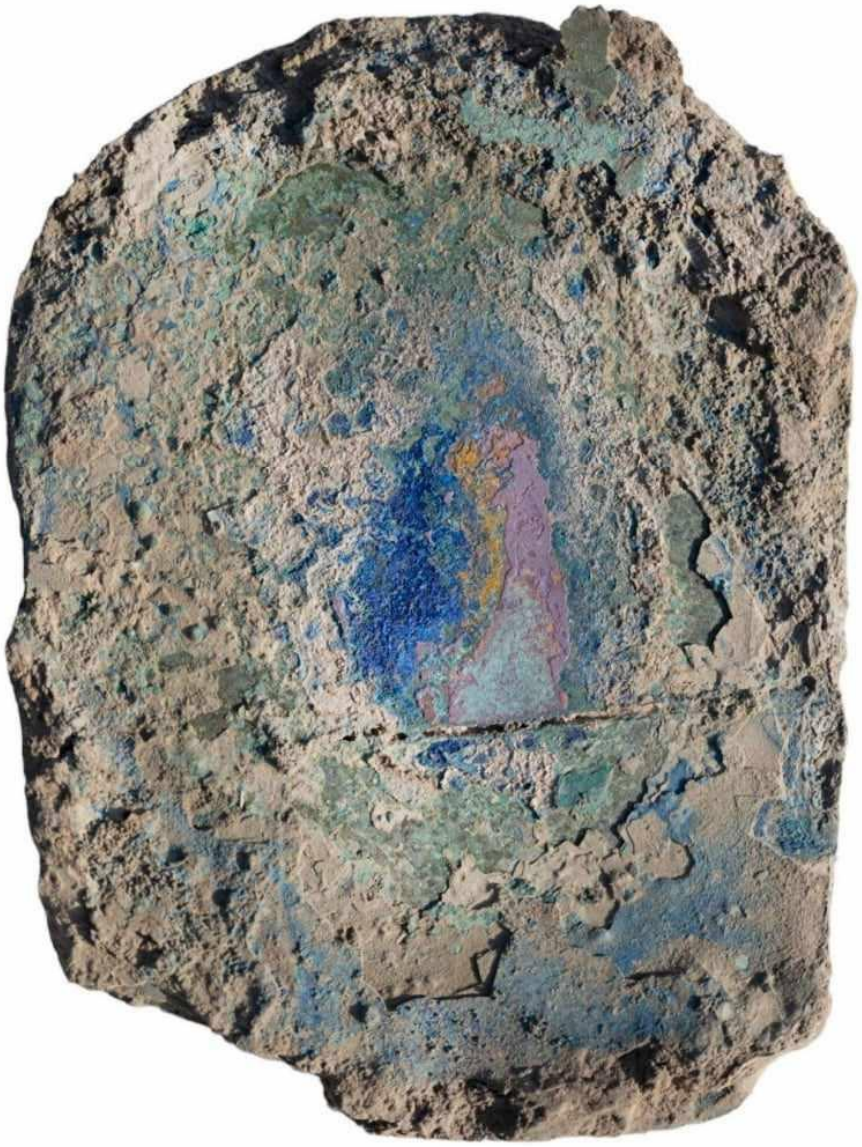

Fig. No. 11: Shouldered Axe

Accessesion No.	-	4NGH_AXE-4
Size	-	19x15x1 cm
Weight	-	1.341 kg
Description	-	It is a shouldered axe.

Fig. No. 12: Shouldered Axe

Accessesion No.	-	4NGH_AXE-4
Size	-	20x16x1 cm
Weight	-	1.453 gram
Description	-	It is a shouldered axe.

Fig. No. 13: Shouldered Axe

Accessesion No.	-	5NGH_AXE-5
Size	-	16x15x1 cm
Weight	-	1.081 kg
Description	-	It is a shouldered axe.

Fig. No. 14: Shouldered Axe

Accessesion No.	-	5NGH_AXE-5R
Size	-	15x13x0.5 cm
Weight	-	502 gram
Description	-	It is a shouldered axe.

Fig. No. 15: Chisel

Accessesion No.	-	6NGH_CHISEL-1
Size	-	23.5x5x0.5 cm
Weight	-	359 gram
Description	-	It is a chisel.

Fig. No. 16: Chisel

Accessesion No.	-	6NGH_CHISEL-1
Size	-	20x5x0.5 cm
Weight	-	331 gram
Description	-	It is a chisel.

Fig. No. 17: Chisel

Accessesion No.	-	6NGH_CHISEL-1
Size	-	22x5x0.5 cm
Weight	-	288 gram
Description	-	It is a chisel.

Fig. No. 18: Chisel

Accessesion No.	-	6NGH_CHISEL-1
Size	-	18.5x5x0.5 cm
Weight	-	277 gram
Description	-	It is a chisel.

Fig. No. 19: Chisel

Accessesion No.	-	6NGH_CHISEL-1
Size	-	19x5x0.5 cm
Weight	-	270 gram
Description	-	It is a chisel.

Fig. No. 20: Chisel

Accessesion No.	-	6NGH_CHISEL-1
Size	-	19x5.5x0.5 cm
Weight	-	351 gram
Description	-	It is a chisel.

Fig. No. 21: Chisel

Accessesion No.	-	7NGH_CHISEL-2
Size	-	21x6x1 cm
Weight	-	490 gram
Description	-	It is a chisel.

Fig. No. 22: Chisel

Accessesion No.	-	8NGH_CHISEL-3
Size	-	27x6x0.5 cm
Weight	-	325 gram
Description	-	It is a chisel.

Fig. No. 23: Bar celt

Accessesion No.	-	8NGH_CHISEL-3
Size	-	25x3x1 cm
Weight	-	228 gram
Description	-	It is a bar celt.

Fig. No. 24: Chisel

Accessesion No.	-	8NGH_CHISEL-3
Size	-	23x5x0.5 cm
Weight	-	355 gram
Description	-	It is a chisel.

Fig. No. 25: Chisel

Accessesion No.	-	10NGH_CHISEL-5
Size	-	14x6x0.5 cm
Weight	-	209 gram
Description	-	It is a chisel.

Fig. No. 26: Chisel

Accessesion No.	-	10NGH_CHISEL-5R
Size	-	23x6.5x0.5 cm
Weight	-	436 gram
Description	-	It is a chisel.

Fig. No. 27: Chisel

Accessesion No.	-	10NGH_CHISEL-5R
Size	-	22x5.5x0.5 cm
Weight	-	315 gram
Description	-	It is a chisel.

Fig. No. 28: Harpoon

Accessesion No.	-	11NGH_HARPOON
Size	-	28x6x2.5 cm
Weight	-	506 gram
Description	-	It is a harpoon.

Fig. No. 29: Copper Foil

Accessesion No.	-	12NGH_CU FOIL
Size	-	27x5x1 cm
Weight	-	103 gram
Description	-	It is a copper foil (thin copper plates used in leather hand guards).

Fig. No. 30: Copper Foil

Accessesion No.	-	12NGH_CU FOIL
Size	-	26x4.5x0.1 cm
Weight	-	83 gram
Description	-	It is a copper foil (thin copper plates used in leather hand guards).

Fig. No. 31: Anthropomorphic Figure

Accessesion No.	-	13NGH_ANTH CU
Size	-	26x36x0.5 cm
Weight	-	1.393 kg
Description	-	It is an anthropomorphic figure.

Fig. No. 32: Harpoon

Accessesion No.	-	15NGH_HARPOON-2
Size	-	38x6.5x1.5 cm
Weight	-	750 gram
Description	-	It is a harpoon.

Fig. No. 33: Harpoon

Accessesion No.	-	15NGH_HARPOON-2R
Size	-	35x8x1 cm
Weight	-	1.060 kg
Description	-	It is a harpoon.

The soil samples were investigated for radiocarbon dating on organic matter associated with the soil which is derived from the surface vegetation contemporary of the time of burial of copper hoards. The elemental carbon and nitrogen, and carbon and nitrogen isotopic composition was ascertained. The detailed method for measurement is described below.

a) **Radiocarbon Dating:** The soil sample was carefully observed under the microscope for any extraneous roots or objects which were removed physically. Additionally, it was ascertained that soil sample is pristine and has not undergone any subsequent contamination after burial. The sample was decarbonated by treating it with HCl to remove any carbonates. The preprocessed decarbonated fraction of soil sample was packed into tin boats and introduced into Elemental Analyzer (Elementar Analysensysteme GmbH, Germany) coupled with '*Automated Graphitization Equipment 3' (AGE3;* Ionplus *AG, Switzerland)* and '*Isoprime precisION*' IRMS (Elementar Analysensysteme GmbH, Germany) present in the Radiochronology and Isotopic Characterization Laboratory, Birbal Sahni Institute of Palaeosciences, Lucknow, India. The organic matter in the sample was converted to graphite with '*Automated Graphitization Equipment 3' (*Ionplus *AG, Switzerland).* The graphitization was made following the protocols described in Agnihotri et al., 2020. The Graphite targets were analyzed at AMS Facility at HEKAL Laboratory, Isotoptech Zrt, Debrecen, Hungary. The samples were measured with standards and blanks, including International Reference standard (IAEA-C3, IAEA-C5) during graphitization and AMS measurements. The radiocarbon dates thus obtained form was calibrated using the online software CALIB 14C Calibration Program ver. 8.2.

b) Elemental and Isotopic Compostion Determination

The soil sample for carbon and nitrogen elemental and isotopic analysis was picked after cleaning the exposed surface and from in-between trapped sediments. The sample was

powdered and homogenised for analysis of Total Organic Carbon (TOC). The sample was further treated with HCl at 80°C to remove carbonates. The sample was then thoroughly washed with deionised wtaer repeatedly to remove any traces of acid. The acid treated sample was kept in oven for complete removal of moisture. The sample was packed in tin boats which were introduced into elemental Analyzer for measuring the TN%, TC%, TOC% of the samples along with its stable isotopic ratios ($\delta^{15}N$, $\delta^{13}C_{TC}$, $\delta^{13}C_{TOC}$). The measurement was done using '*Vario Isotope Select*' Elemental Analyzer (Elementar Analysensysteme GmbH, Germany) coupled with '*Isoprime precisION*' IRMS (Elementar Analysensysteme GmbH, Germany) present in the Radiochronology and Isotopic Characterization Laboratory, Birbal Sahni Institute of Palaeosciences, Lucknow, India.

Results: The AMS radiocarbon dates obtained for the copper hoard finds of Nigohi were found to be ranging from 3610 cal BP to 4330 cal BP, which corresponds to Late to Mature Harappans (1670 BCE to 2380 BCE) (Table 1). The radiocarbon dates can be put in two categories, one ranging from 1670 BCE to 1903 BCE, and other from 2245 BCE to 2380 BCE.

Sample ID	AMS lab ID	BSIP ID	Radiocarbon Age	Calibrated Age range (years BP)	Mean Age (years BP)	Calibrated age Range (BCE)	Mean Age (BCE)
10NGH_Chiesel-5	I/3639/84	BSIP/2023/67	3801 ± 53	4090-4289	4193	2141-2340	2244
1NGH_Axe-1	I/3639/85	BSIP/2023/68	3903 ± 58	4247-4416	4328	2298-2467	2379
2NGH_Axe-2	I/3639/86	BSIP/2023/69	3384 ± 50	3518-3693	3619	1569-1744	1670
3NGH_Axe-3	I/3639/87	BSIP/2023/70	3558 ± 55	3726-3961	3852	1777-2012	1903
6NGH_Cheisel-1	I/3639/88	BSIP/2023/71	3860 ± 56	4159-4403	4282	2210-2455	2331

Table 1: AMS radiocarbon dates with their calibrated age range for the soil samples associated with Copper hoards from Nigohi. Radiocarbon ages calibrated using Calib 8.2

Sample ID	TC%	TOC%	TOC/TN	$\delta^{13}C_{TOC\ (VPDB)}$
NGH_Axe-1	1.00	0.80	ND	-19.2
NGH_Axe-2	0.98	0.57	ND	-18.7
NGH_Axe-3	0.92	0.57	ND	-18.7
NGH_Axe-4	0.80	0.63	ND	-18.7
NGH_Axe-5	0.70	0.47	ND	-18.9
NGH_Axe-5R	0.70	0.44	ND	-19.3
NGH_Chiesel-1	0.45	0.37	ND	-20.0
NGH_Chiesel-2	0.46	0.40	ND	-19.5
NGH_Chiesel-3	0.68	0.34	ND	-19.4
NGH_Chiesel-4	0.53	0.46	8.0	-22.8
NGH_Chiesel-5	0.86	0.64	12.3	-19.7
NGH_Chiesel-5R	0.88	0.62	13.7	-20.1
NGH_Harpoon	0.60	0.44	9.6	-19.1

NGH_Cu foil	0.47	0.32	5.8	-22.1
NGH_Anth Cu	0.70	0.52	10.0	-19.6
NGH_Harpoon-2	1.29	0.49	15.0	-19.0

Table 2: Elemental and isotopic composition of Carbon in the soil samples associated with Copper hoards from Nigohi.

TN- Total Nitrogen; TC- Total Carbon; TOC – Total Organic Carbon; ND – Not Detected; R - Repeat Samples

To ascertain the provenance of soil associated with the copper hoards, elemental and isotopic composition of carbon and nitrogen was carried out. The C/N ratio is indicative of the provenance of sediments whether it is from terrestrial or marine source. The stable isotopic composition of carbon also indicates the source of carbon in the sediments, and it is a more robust proxy. The $\delta^{13}C$ of the soil sample recovered from the copper weapon burial site ranged mostly from -18 to -22 per mil with C/N ratio ranged from 8-15, which primarily indicates that soil obtained from the site were mostly terrestrial possibly sourced from lacustrine environment.

This study can culminate into a very important archaeological scientific investigation, once detailed excavation of the site is undertaken. This would unravel the cultural history of the site along with the social, economic and climatic conditions under which the civilization thrived. Extensive research is currently under progress to address additional climatic and archaeological factors.

Discussion: Earlier the OCP culture was considered to be the degenerate phase of Harappan culture derived from mature Harappan culture but OCP pottery shapes were not similar to those of Harappans. OCP is not even close to the pottery that have been recovered from eastern Neolithic and Chalcolithic sites like Koldihwa, Chirand, and Lahuradewa[2]. The Upper Ganga OCP's forms are found at the sites of Bara, Sothi-Siswal, Ganeshwar, Jodhpura, Bhagwanpura, Hulas, Jhinjhana, Alamgirpur, Lal Qila, Atranjikhera, Saipai and Sankissa. In the east, OCP was reported from Kannauj[3], from different sites of Sitapur[4], Bahraich[5], Ayodhya[6] & Sultanpur[7] by the third author (Fig. below).

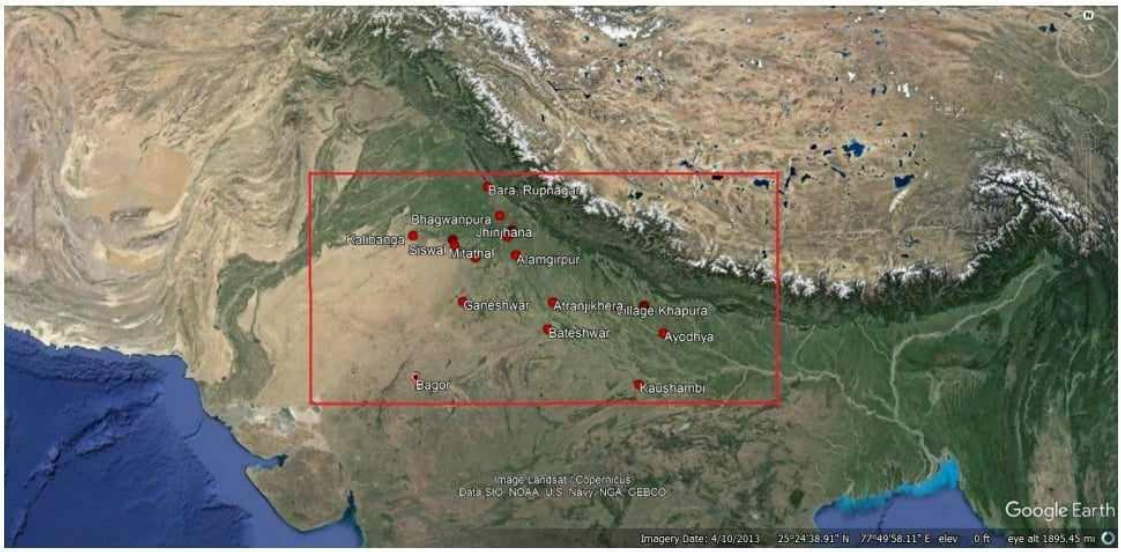

Fig. No. 34: Location of OCP sites shown in the map of India

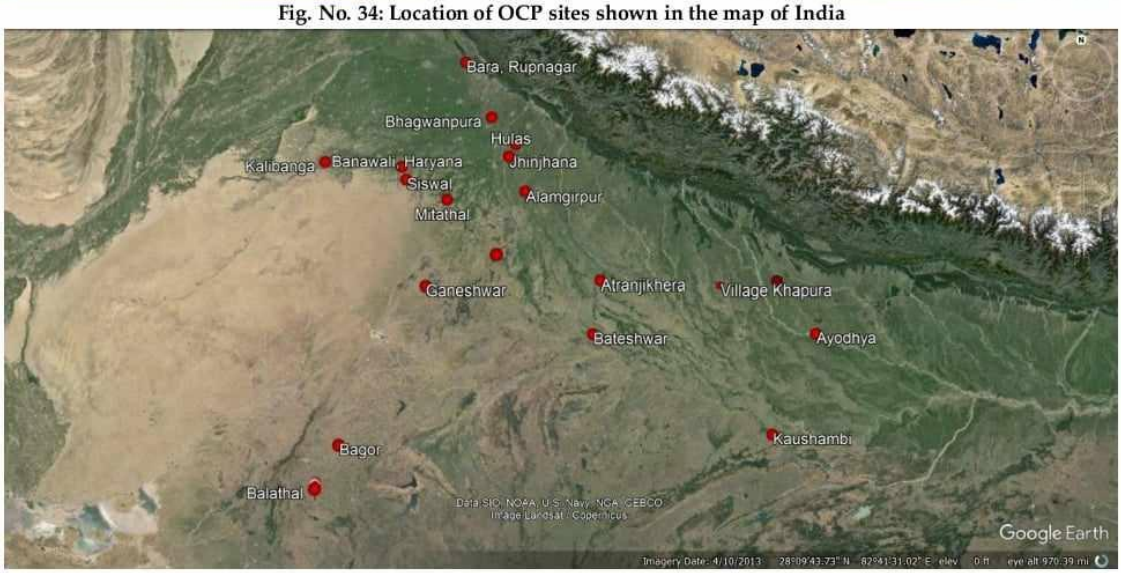

Fig. No. 35: Location of dated OCP/ kindred sites shown in the map of North & western India

There are generic parallels between OCP and the protohistoric period ceramics from Kalibangan and Balathal. The later chalcolithic potteries found from Balathal, Gilund, Ahar in Rajasthan & Kaytha in M.P. have generic similarities to the ceramic of OCP. It appears that OCP and central Indian pottery are related to each other but central Indian cultures didn't use Harpoons.

The radiocarbon dates from different OCP sites and sites having generic similarities with it have been summarized in the following table.

S. No.	Site	Dates (Carbon/TL)
1.	Bhagwanpura[8]	2190 to 3510 BC
2.	Sothi-Siswal[9]	3200-2600 B.C.
3.	Jhinjhana[10]	TL date 2650 B.C.
4.	Lal Qila[11]	TL date 2030 B.C.
5.	Atranjikhera[12]	TL date 2280 B.C.
6.	Ganeshwar[13]	2895–2515 B.C.
7.	Jodhpura[14]	3360–2880 B.C.
8.	Kalibangan[15]	5000 B.C.
9.	Balathal[16]	4540-4340 BC
10.	Hulas[17]	3318 to 2468 BC
11.	Bagor[18]	3160 BC to 5365 BC
12.	Bateshwar[19]	3330-3090 B.C.

Table No. 3: showing dates found from different OCP sites

The above dates clearly demonstrate that the area of OCP culture was inhabited by the people of early OCP culture much before the start of Mature Harappan phase and they outlived them.

Conclusion: The five radiocarbon dates of the contemporary soil samples associated with copper hoards collected from the Nigohi range from 1670 BC to 2380 BC (Table 1). These copper hoards linked with OCP show very early date. It indicates that OCP culture was contemporary to Mature Harappan culture. The source of soil samples was terrestrial and the site was located in lacustrine environment.

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